Chapter 14
The Netherlands

14.1 INTRODUCTION

In 2002, 166 new turbines were installed in the Netherlands with a capacity of 217 megawatts (MW). NoordzeeWind was selected as the consortium to build and exploit the demonstration 100-MW Near Shore Wind Farm. A change was initiated in the various financial, planning, and research and development (R&D) instruments that are facilitating demand for renewables.

14.2 NATIONAL POLICY

The government policy and targets for renewable energy were revised in 2001. Wind and biomass energy are new priorities and are supposed to give the greatest contributions to the 2020 target. The realization of 6,000 MW of installed wind capacity offshore is seen as possible and necessary. The targets are summarized in Table 14.1.

Strategy

The government will create the conditions to reach these targets through various instruments that facilitate demand for renewables: amongst others, continuation of fiscal incentives and financial instruments, spatial planning; research programs, a competitive green market, administrative agreements, research and demonstration programs, carbon dioxide reduction subsidies, and joint implementation mechanisms.

Progress Towards National Targets

In 2001 about 1.3% of national energy consumption was provided by renewable energy. Numbers for 2002 are not yet available.

14.3 COMMERCIAL IMPLEMENTATION

Installed Capacity

In 2002, 166 turbines were installed with a capacity of 217 MW, and 40 turbines with a capacity of 15 MW were removed. This brings the total installed capacity at the end of 2002 to 685 MW. The final numbers for 2001 show a total increase in operational capacity of 42 MW. See Figure 14.1.

Rates and Trends in Deployment

The net increase installed capacity in 2002 of 202 MW is twice as much as in the previous record year, 1995. The average installed

Targets	2005		2010				2020			
	%	TWh	%	PJ	TWh	MW	%	PJ	TWh	MW
Energy from RE			*5*	150			*10*	300		
Electricity from RE	*6*	6.5	*9*	10.6						
Possible from wind				20	3.5	*1,500*		130	22.4	*7,500*

Table 14.1 Targets renewable energy in percentage of RE or electricity in italic. Avoided fossil fuel in PJ.

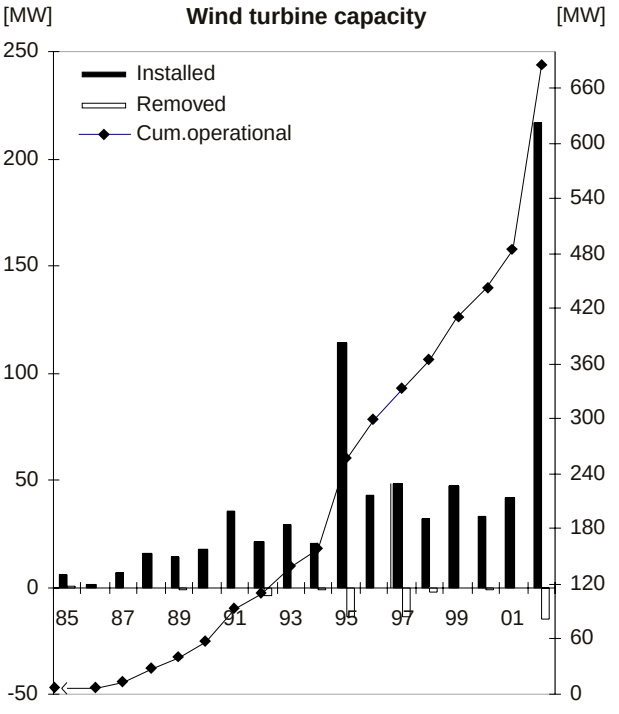

Figure 14.1 Installed, removed, and operational wind capacity

capacity per turbine doubled from 650 kilowatts (kW) in 2001 to 1,300 kW in 2002. The average hub height rose to 66 meters (m), and the installed swept area per unit of power continued to be stable at about 2.5 m^2/kW. See Figure 14.2.

Contribution to National Energy Demand

Total national electricity consumption in 2001 was 103.495 gigwatt-hours (GWh). Wind provided about 0.8% of it, which amounts to 825 GWh of electricity. In 2002 we expect the national consumption to be 106.815 GWh with wind providing 0.94% of that, which amounts to 1,006 GWh (see Table 14.2). In a normal wind year, the installed capacity of 685 MW can generate about 1,400 GWh of electricity.

14.4 MARKET DEVELOPMENT AND STIMULATION

Main Support Initiatives and Market Stimulation Incentives

The history of support initiatives and market stimulation instruments including fiscal incentives can be found in the IEA Wind Energy annual reports for 1999, 2000, and 2001. Information about the competitiveness of prices can be found on the Internet at www.greenprices.com. At the end of 2001, about 800,000 households bought renewable electricity at the same price as grey electricity. In 2002 this almost doubled, to 1.4 million households.

After the elections in May, the new Netherlands government decided to change the financial framework for renewable energy stimulation for the following reasons.

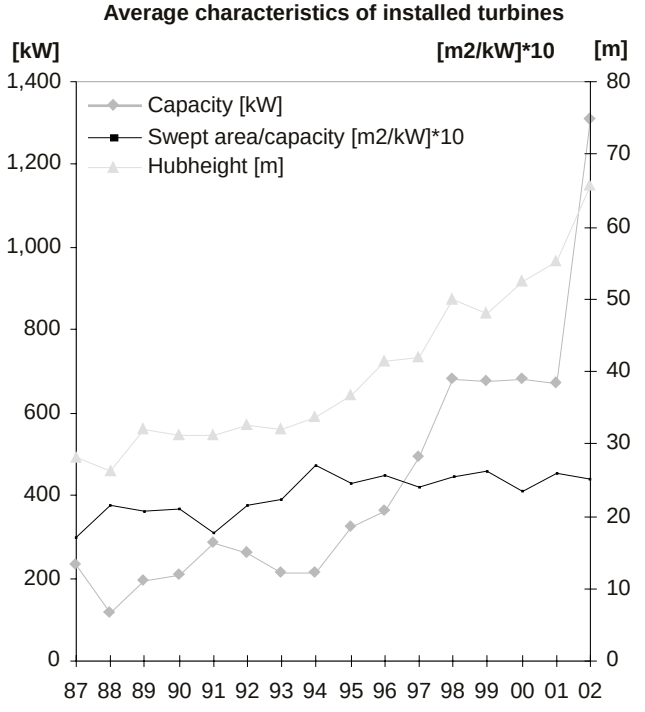

Figure 14.2 Average characteristics of installed turbines

• The market for green energy was liberalized from July 2001

• The market for grey energy will be fully liberalized from January 2004

• About 1.4 million households bought renewable energy at the same price as grey energy

• Large-scale import of electricity from existing production units (among others, biomass from Sweden and hydro from Norway and Switzerland) created a flow of about 140 million Euro of taxpayers' money out of the country in 2002 through the Feedback Eco tax for producers

• Due to lack of effective relevant European Union (EU) directives in Europe, there is no level playing field for renewable energy.

The state budget for 2003 (announced in September 2002) includes more details about the change of the financial framework. The budget initiated intense public discussions with the producers of renewable energy, the energy companies, parliamentarians, and the government, especially about the size of the reimbursement. It became clear that legislation could not be finished before the first quarter of 2003. This was also influenced by the fact that the government fell in October/November. New elections for Parliament were held in January 2003 and a new government will take over.

In the meantime, temporary legislation will be effective from 1 January 2003. Main elements are that the Feedback Eco tax of 0.02 Euro/kWh for imported green electricity is canceled; the Eco tax for consumers is 0.0639 Euro/kWh but the exemption for customers that buy green electricity is 0.0464 Euro/kWh; the yearly budget for Energy Investment Deduction (EIA) is decreased, but wind will still be eligible; and energy invest-

Year	Generated electricity	Primary energy savings	Electricity consumption
	[GWh]	[PJ]	[TWh]
1985	6	0.05	
1986	7	0.06	
1987	14	0.12	
1988	32	0.27	
1989	40	0.33	
1990	56	0.46	
1991	88	0.73	
1992	147	1.22	
1993	174	1.44	
1994	238	1.97	
1995	317	2.62	85,641
1996	437	3.62	88,665
1997	475	3.93	92,000
1998	640	5.30	95,421
1999	645	5.34	97,549
2000	829	6.86	100,604
2001	825	6.80	103,495
2002	1,006	8.29	106,815
*2002 numbers have been estimated			

Table 14.2 Electricity production, avoided fuel and electricity consumption. (Source 1 & 2)

ments will no longer be eligible for Free Depreciation (VAMIL).

Since the announcement of the change in fiscal instruments in June 2002, investors have put their investment decisions on hold. The market is waiting for final legislation, in which all the details will be clear. Especially crucial for their investment decisions is the size of the reimbursement on production of green electricity.

Unit Cost Reduction

There are no reliable statistical data for 2002, but the indications point to a slight increase in project costs. The best estimates are e1,100/kW for project costs with 900 e/kW for turbines, 125 Euro/kW for electrical infrastructure, and 75 Euro/kW for project development.

14.5 DEPLOYMENT AND CONSTRAINTS

Wind Turbines Deployed

Of the wind turbines installed in 2002, 59% are from Vestas. New turbine types were the Nordex N80/2500 and the Lagerwey LW70/2000 prototype. See Table 14.3.

Ten wind farms with an installed capacity higher than 10 MW were installed. The largest is 22.5 MW with 9 Nordex 2.5-MW, 80-m turbines at the refinery of Nerefco (daughter of BP and Texaco) at the Rotterdam harbor (see Figure 14.3). The second largest is with 12 Vestas 1.65-MW, 66-m turbines at Middenmeer. Table 14.4 gives the details. Further details can be found at http://home.wxs.nl/~windsh/nwturtab02.html.

Operational Experience

There were no major incidents or accidents in 2002.

Main Constraints on Market Development

Spatial planning.
The main challenge for wind on land is still securing enough sites for wind turbines.
In July 2001 the Administrative Agreement National Development Wind Energy (Dutch acronym BLOW) was signed by the ministers of Housing, Spatial Planning, and the Environment; the ministry of Economic Affairs; the sub secretaries of state of Agriculture, Nature Management, and Fishing; and the sub secretary of state of Traffic and Waterstate and of the Department of Defence. Co-signing were the provinces and the Association of Dutch Communities.

Manufacturer	Turbines	Installed		Rotorarea
	[-]	[MW]	[%]	[m²]
Vestas	95	127.6	59%	287,073
Nordex	15	27.3	13%	57,020
NEG-Micon	29	25.8	12%	62,144
Enercon	7	12.6	6%	26,939
GE Windenergy	8	12.0	6%	31,229
Bonus	9	8.0	4%	19,182
Lagerwey	3	3.5	2%	8,756

Table 14.3 Distribution of new wind turbines by manufacturer

The agreement is aimed at realizing 1,500 MW of wind capacity on land in 2010.

Each province has a target to designate locations for wind turbines specified in megawatts before 2005. The agreement required action plans before June 2002, and all but one have been submitted.

Supporting spatial planning
Novem has formed a so-called BLOW Expert Pool of certified independent consultants to assist provinces and local councils that do not have sufficient expertise with their activities to establish regional and local spatial planning for wind. Up to half of the costs, to a maximum related to the amount of megawatts of the wind farms to be realized, are subsidized by Novem.

Novem has published supporting instruments on two CD-ROMs. One is called 'Met de wind in de rug' and it contains the entire knowledge base of spatial planning for wind in step-by-step plans for realization of a wind project and an encyclopaedia with important information about financing, law texts, and regional spatial plans. The other is the 'Handboek Risicozonering.' It treats all risk aspects of wind turbine locations on dikes, roads, railway lines, industrial plants, waterways, industrial zones, residential buildings, underground cables and pipes, high-voltage lines, etc. Also treated are zoning near airport flight paths and radio-telecommunication links. It contains much scientific data and examples of calculations for individual risk, group risk, etc. The Handbook was made by ECN on the order of Novem and was pre-

Figure 14.3 2.5-MW wind turbines at Nerefco refinery

Wind farm > 5MW	Manufacturer	Turbines	Height	Diameter	Capacity	Swept area
		[-]	[m]	[m]	[MW]	[m²]
Rotterdam-Europoort,	Nordex	N80/2500	80	80	22.5	45,239
Middenmeer,	Vestas	V66/1650	78	66	19.8	41,054
Dronten, Eland - Wisentweg	Vestas	V80/2000	67	80	14.0	35,186
Dronten,	Enercon	E70/1800	70	70	12.6	26,939
Biddinghuizen,	Vestas	V66/1650	67	66	12.3	23,948
Rotterdam,	GE Windenergy	GE70.5/ 1500	67	71	12.0	31,229
Biddinghuizen,	Vestas	V80/2000	68	80	12.0	30,159
Zeewolde,	Vestas	V66/1650	67	66	10.5	20,527
Lelystad,	Vestas	V66/1650	67	66	10.5	20,527
Swifterbant,	Vestas	V66/1650	67	66	9.9	20,527
Kapelle,	NEG-Micon	NM52/900	70	52	9.0	21,237
Zeewolde, Wulpweg	Vestas	V52/850	70	52	7.7	19,113
Zeewolde,	Vestas	V52/850	55	52	7.7	19,113
Etten-Leur	Bonus	B62/1300	66	62	6.5	15,095
Zaewolde,	Vesta	V52/850	70	52	6.0	14,866
Various < 5MW	Danish, Dutch, German	-	-	-	44.0	107,581
TOTAL					216.8	492,343

Table 14.5 Size of wind plant installed in 2002

sented at the Global Wind Power Conference 2002 in Paris.

Streamlining procedures spatial planning
The government is also aiming to streamline and shorten the procedures for building permits. In 2002 the government carried out an investigation into the bottlenecks of wind projects. This will be followed in 2003 with an operation that aims to evaluate the entire complex chain of laws and rules that apply to wind projects. The ambition is to shorten the process to 2.5 to 3 years and to strive for one integrated permit.

14.6 ECONOMICS

Trends in Investment

Based on an average price of 1,100 Euro/ kW, the investment in wind turbines totalled 238 million Euro in 2002.

Trends in Unit Costs of Generation and Buy-Back Prices

The total pay-back rate offered by energy companies for 5- to 10-year contracts in 2001 was between 0.068 and 0.080 Euro/kWh. No numbers are known for 2002, mainly due to the commercially sensitive nature of the contracts. After the government announcement

of the change in the financial framework for renewable energy stimulation contracts, the energy companies put negotiations on hold.

14.7 INDUSTRY

Manufacturing

In December, NEG-Micon Holland announced that it would stop production of wind turbines in the Netherlands.

Lagerwey erected the prototype of its 1.5-2 MW prototype Zephyros turbine in May (see Figure 14.4) on the Maasvlakte facing the North Sea. The advanced turbine features a 3-kilovolt (kV), permanent magnet direct-drive generator, developed in close co-operation with ABB Finland. It has a rotor diameter of 70 m , rotor speed of 18 to 24 revs/min, individually pitched blades, and full ac/dc/ac conversion based on IGCT technology from ABB.

Industry Development and Structure

Offshore heavy lift specialist Mammoet; dredging, offshore, and marine construction works contractor Van Oord ACZ; and other shareholders including Hovago Cranes and Marine Construct have joined forces in the field of offshore wind farm installation. The new venture will operate under the name Mammoet Van Oord. To this end, a Jackup Installation Barge has been developed and built. Apart from Mammoet and Van Oord ACZ, other shareholders are Hovago Cranes (a member of the Baris group) and Marine Construct. Mammoet Van Oord's activities will also comprise all onshore transport and the installation of scour protection around the wind turbines and the shore.

Measuring 91 m long, 33 m wide, and 7 m high, the Jackup Barge, dubbed "Jumping Jack," features four 42-m-high legs that will lift the barge out of the water to keep the vessel secure on the seabed, creating a stable working platform for the installation work. See Figure 14.5. A specially developed hydraulic winching system will allow the barge to raise and lower its legs while bearing a load on deck so that it can quickly move from one turbine to another. The pontoon on the barge has been designed to carry heavy loads (up to 4,000 tons) to and from port without the need for auxiliary pontoons. It is equipped with a 1,200-ton crane, which is sufficient for the lifting of current and future large offshore wind turbines. It can be fitted with various other cranes if necessary.

14.8 GOVERNMENT-SPONSORED R,D&D

Novem's wind program ended in the year 2000. In 2001 and 2002, Novem carried out the Renewable Energy program, in which all

Figure 14.4 Erection of Lagerwey 1.5 to 2 MW prototype

Figure 14.5 Jumping Jack offshore installation barge

renewable options compete for subsidy in a tender process.

Priorities

The Netherlands R&D-strategy Wind Energy 1999-2003 (NRW) was still the background for the research programs of ECN and TU Delft in 2002. Priority subjects are listed here.

- New developments: Offshore, innovative materials, and recycling
- Testing and measuring: Condition-monitoring systems and wind turbine test facilities
- Databases: Failing of wind turbines and components
- Design tools: Reliability, wind turbines, control, and aerodynamics.

Awarded Contracts Under Novem Renewable Energy Program

From the 18.2-million-Euro subsidy in 2001 available for renewable energy, about 2.4 million Euro was allocated to these wind energy research projects:
1. Optimat BLADE, reliable optimal use of materials for wind turbine rotor blades;
2. Implementation of a computer code to analyse offshore wind turbines the frequency domain;
3. Design tool for integrated design of wind turbine control mechanisms;
4. Design of a prototype Smart Tower (tubular pre-stressed concrete);
5. Analyse, characterize, interpret, and quantify flow phenomena in aerodynamic field measurements on wind turbines;
6. Sound detection capabilities of porpoises in noisy environments;
7. Development of a detection system for

collision of birds against wind turbines (WT-Bird);
8. Farm effects of large offshore wind farms;
9. Electric and control aspects of offshore wind farms, phase 2.

From the 2002 budget, only the projects of the first tender have as yet been allocated. From a total of 9.1 million Euro for renewables, 2.5 million Euro was awarded to these wind research projects:
1. STABCON, aëroelastic stability control of large wind turbines;
2. Demonstration of an offshore access system;
3. CONMOW, condition monitoring of offshore wind turbines;
4. IEA Annex XX, analysis of NASA Ames wind tunnel measurements;
5. FYNDFARM, computer code for design and optimization of wind farms for maximum energy yield, in relation to fatigue loads from wakes and noise emission;
6. IEA Annex XVII, Netherlands contribution to Database Wind Characteristics;
7. Development of offshore wind energy standards;
8. Extrapolation of extreme external loads.

Summaries in Dutch of the project proposals can be found on the Internet at www.den.novem.nl under Gehonoreerde BSE-projecten Windenergie.

New R,D&D Developments; Revision of R&D Policy

Energy research financed by the Department of Economic Affairs through institutions (about 100 million Euro/yr) is fragmented and covers too many subjects. The Department started a review in the so-called Energy Research Strategy (EOS) project in 2001. The Department wants to make clear choices in thrust areas and in other areas to work through international co-operation. Thrust areas are subjects where the Netherlands has strength and that contribute to the transition to a sustainable society. Import of knowledge is preferred in areas where the Netherlands has less strength. A preliminary chosen thrust area is offshore wind.

In 2002, interest groups and stakeholders were consulted and the strategy was further detailed. The final report defined five priority areas. In the area of electricity grids and generation, offshore wind is one of the thrust areas. The new strategy will be further detailed in 2003 with the choice of instruments of implementation and organization of platforms of stakeholders. It will be operational in 2004.

Offshore Siting

In the coming years, further information on the following subjects will be available from the web site www.windopzee.nl.

Offshore siting
In October 2001, the government issued the final draft of the Spatial Core Decision (Vijfde Nota Ruimtelijke Ordening), which designated a preferred area on the Dutch continental shelf for 6,000 MW of wind capacity. In 2002, the discussion about the final draft by the government, Parliament, and prospective offshore wind developers started to reconsider these preferred areas. The Departments of the Environment, Traffic and Water, State and Economic Affairs are thinking in the direction of either designating larger preferred areas or opening up the entire Exclusive Economic Zone for wind power development except for hard exclusions due to, for example, ship traffic and military practice zones.

A study "Multiple Use of Space on the North Sea," concentrating on the combination of wind energy and other activities, was carried out by a working group from all concerned departments. It concluded that the opportu-

nities are relatively limited for gaining more sites for offshore wind energy by combining this activity with other activities. A simultaneous combination of wind energy and ship traffic, oil and gas exploration, fishing, mining, dredging, military use, cables, recreation and tourism, nature, and other constructions is often blocked by several safety problems. Furthermore, in most cases there aren't any advantages from the combination for the "owners" of these activities. Successive combinations of wind energy and these activities (first one activity, then wind energy, or vice versa) offer more opportunities. Depending on the type of combination, this can take considerable time.

Offshore concessions
In 2001, the government announced that before the end of 2003 a concession regime shall be in place to allocate areas where wind developers can build offshore wind farms. During 2002, a draft concession regime was discussed with prospective offshore wind developers. The discussion will continue in 2003.

Offshore grid integration
To be able to integrate wind power offshore in the grid, Novem, on the order of the Ministry of Economic Affairs, carried out the "Survey of Integration of 6,000 MW Offshore Wind Power in Netherlands Electricity Grid in 2020." This inventory to tried to answer the following questions.

- What are the technical, organizational, financial, and administrative/legal consequences of the future integration of 6,000 MW of offshore wind power in the Netherlands' electricity grid?
- What measures do the involved parties have to take, including their responsibilities to realize the integration of this capacity in the period 2002 to 2020?
- What are the (financial) consequences for the involved parties?

Representatives of the Netherlands grid managers were involved to select scenarios and criteria for the inventory. Novem contracted a study to KEMA, which carried it out together with the Delft Technical University. It involved (1) system studies, to look into the necessary technical adaptations and investments in the grid; (2) technical studies of short- (seconds to minutes) and long-term (15 minutes to days) balance of the electricity system; (3) economics of the present electricity market; and (4) administrative/legal study of offshore wind energy.

The study showed that the extra investment costs for the necessary grid reinforcements of the 380-kV grid for wind capacity varies between 275 million Euro and 570 million Euro. This constitutes about 3% to 5% of the estimated investment in 6,000 MW offshore wind capacity. It gives a qualitative description of maintaining the short-term energy balance during disruptions and conditions of high wind and low load and the influence on available regulating power. Also, it gives a qualitative description of how to maintain the long-term power balance, its effect on partial loads of conventional units and their operation and maintenance, and the needs for wind forecasts. It describes the responsibilities of the government and grid manager for in-depth investments of grid reinforcements and possible changes in regulations for planning and cost recuperation. Finally, it details applicable law for grids and building offshore wind farms within and outside the territorial zone and gives recommendations on how to investigate and overcome uncertainties in this regard.

Offshore demonstration Near Shore Wind Farm and Measuring and Evaluation Program

NoordZeeWind, a consortium consisting of Shell Renewables and NUON, was announced the winning consortium according to selection rules for the 100-MW demonstration Near Shore Wind Farm (NSW) to be built offshore near Egmond aan Zee. The consortium will be entitled to apply for the building permit.

The wind farm will be built 12 kilometers (km) from the coast in water 15 m to 20 m deep. The turbine will be 36 NEG-Micon 2.75-MW, 92-m-diameter, built on a monopile.

The Near Shore Wind Farm is meant to gather knowledge and experience to enable construction and exploitation of large wind farms far in the North Sea at water depths up to 40 m and distances over 40 km. That is why an extensive Measuring and Evaluation Program (NSW-MEP) is connected to the demonstration. The document Measuring and Evaluation Programme (NSW-MEP) describes the mandatory and desired measurements to be carried out in the area of technology and economy and the area of nature, environment, and other use functions. It is based on an inventory of the learning objectives of all directly involved parties – government, lobbyists, and commercial companies. Novem elaborated the learning objectives in this NSW-MEP. The aim of this NSW-MEP is to collate knowledge and make it generally available. Account must be taken of the other monitoring programs conducted in the Netherlands and beyond. Double work must be avoided and the results of others should be used wherever possible, while others, in turn, are free to use the results of the NSW-MEP.

The government is responsible for a limited number of the necessary learning objectives for the nature and environment component. These are indicated in the NSW-MEP by the term "quantitative detailed approach by central government."

The NSW operator is responsible for collecting and supplying data of the NSW-MEP. The collection of data comprises the design and installation of the measuring infrastructure needed and conducting studies by itself or by third parties. The complete text of the NSW-MEP can be downloaded from the web site, www.nsw-mep.nl.

Project organization NSW-MEP

On the order of the government, Novem takes care of the project organization NSW-MEP. The Project Organization promotes the learning objectives and assures that they can be reached. It reports results to the Department of Economic Affairs.

For the collection of data on nature and environment, Novem is collaborating with the State Institute for Coast and Sea (RIKZ). This is a part of the Directorate North Sea of the Department of Traffic and Waterstate.

First, measurements of the undisturbed conditions of nature and the environment will be taken at the end of 2003. Then assessment of technology and economy will be made in either late 2004 or 2005.

References:
1. Duurzame energie in Nederland, Bijdrage aan de energievoorziening 1990-2001. Renewable energy in the Netherlands. Contribution to the energy supply 1990-

2001. Final version], November 2002, Novem and CBS.
2. CBS Central Bureau of Statistics, publication Electricity Balance 1995 – 2001, January 23, 2003.

Author: Jaap L. 't Hooft, Novem, the Netherlands.